Test of Integration of CALIFA into R3B*

T. Le Bleis[1], *M. Bendel*[1], *R. Gernhäuser*[1], *J. Hoffmann*[2], *H.T. Johansson*[3], *N. Kurz*[2], *I. Lazarus*[4], *H. Simon*[2], *M. Winkel*[1], *and the R*^{3}*B-CALIFA Collaboration*[2]

[1]E12, Physik-Department, Technische Universität München, Garching bei München, Germany; [2]GSI Helmholtzzentrum für Schwerionenforschung GmbH, Darmstadt, Germany; [3]Chalmers University of Technology, Göteborg, Sweden; [4]Sci. Tech. Daresbury, Daresbury, UK

CALIFA [1] is the γ-ray and large-angle high-energy particle detector for the R^{3}B setup at FAIR. Due to the physics requirements, CALIFA is composed of two pieces: a barrel that surrounds the beam axis and an end cap that closes the barrel in the forward direction. The barrel is composed of 1952 long CsI crystals connected to APDs.

The signals from the APDs are preamplified using Mesytec MPRB-16 with the differential output directly connected to FEBEX3 boards [2], developed at GSI, which host a 50 MHz, 14 bit fast sampling ADC per channel and a Lattice LFE3-150 FPGA where the pulse shape is analysed to determine the energy of the detected particle and its identity. Each FEBEX3 can analyse up to 16 channels and is located in a specially designed PCIe crate. Using the GOSIP protocol on optical fibres, and a minimum set of cables, data are collected on a PC.

Detector Triggers

Currently, the LAND setup in Cave C is fully based on MBS [3]. Each branch is equipped with a processor and a GSI-TRIVA trigger module, which guarantees a fully synchronous trigger and read-out. The triggers from different detectors are collected into a single GSI-VULOM module, whose firmware performs different logic for event and calibration trigger generation [4]. Through a long copper-based trigger bus, trigger and dead-time information is distributed between the master system and all slaves. It was observed during the 2012 experiments that signal integrity of the trigger bus constrains the size of the system.

R^{3}B at FAIR will be composed of larger systems (e.g. NeuLAND, recoil tracker and CALIFA), which due to high granularity, can accept a much higher event rate, and hence trigger rate (e.g. CALIFA could produce triggers and record data in the range of 2.5–35 kHz[1]). However, increased detector segmentation creates difficulties for the trigger logic, when based on simple combinations of an increasing number of channels. The validity of the selected events will reduce as the rate of the noise triggers increase. In order to keep reasonable event triggers, more advanced logic has to be applied at the detector level to reduce the background rate as early as possible. E.g. a local trigger connection between CALIFA and the recoil tracker is planned in order to reject very high rate of background from the delta electron hits in the R^{3}B Recoil Tracker based on fast ($\approx$1 μs) indication of proton detection in CALIFA.

* Work supported by BMBF(06MT9156) and DFG (EXC153).

[1]Depending on the reccording mode.

R^{3}B Setup Integration

The aim is that at the time of running at FAIR, the systems either include an interface to the BuTiS [5], called White Rabbit [6], or be able to handle the corresponding protocol. That way, some systems can be integrated in the master dead-time domain of the setup, while others are synchronised by an exchange of triggers and/or timing signals. Development for the White Rabbit has been launched and first tests are planned with detector demonstrators in 2014.

In a first step, intermediate solutions are developed, that allow integration of relatively different systems, based on event- and time-stamping [7, 8]. Two implentations of those concepts have been tested in Nov. 2012 during the S406 experiment. Some prototypes of CALIFA were synchronised using event tags generated by a VULOM in the LAND setup. The trigger signal, a trigger counter and a clock were received by the CALIFA electronic. This allowed a post-acquisition synchronisation, even for systems running different acquisition protocols (e.g. different MBS version, MBS and TRB).

Another protocol based on time stamping, originally developed to synchronise detectors located at the S2 position of the FRS, was also used during the S406 experiment for other detectors located in Cave C. Here, a serial protocol, which uses only one line for the transmission, allows additional systems to have a comparable time marking of the event as the master system. The synchronisation message is sent every 80 μs with a precision of 20 ns. The time between the synchronisation words can be used, to send some auxillary information, e.g. calibration triggers.

References

[1] CALIFA Collaboration, “Technical Design Report for the CALIFA Barrel.”, November 2011.

[2] J. Hoffmann *et al.*, “New TASCA Data Acquisition Hardware Development for the Search of Element 119 and 120”, GSI Scientific Report 2011, p. 253.

[3] H.G. Essel and N. Kurz, “The general purpose data acquisition system MBS”, IEEE TNS Vol.47 No.2 (2000) p. 337.

[4] H.T. Johansson et al., GSI Scientific Report 2010, p231.

[5] P. Moritz and B. Zipfel, GSI Scientific Report 2011, p. 478.

[6] J. Serrano *et al.*, “The White Rabbit Project”, Int. Conf. on Accelerator and Large Experimental Physics Control System, October 2009.

[7] E.S. Paul *et al.*, Physical Review C Vol 51 No.1 (1995) p. 78.

[8] J. Hoffmann and N. Kurz GSI Scientific Report 2002, p. 224.